

SOURCE INVENTORY

CATEGORIES # 1130 - 1132

COMMERCIAL AIRCRAFT, Piston

1999 EMISSIONS

Introduction

Considered in these categories are emissions from commercial aircrafts during their operations at the three major airports in the Bay Area, namely, San Francisco International Airport, Oakland International Airport, and San Jose International Airport. A classification system for commercial aircraft was formulated consisting of major passenger, cargo, and commuter/air taxi. The commuter/taxi class is primarily of the piston type.

In the piston engine, the basic element is the combustion chamber. Mixtures of fuel and air are burned in this chamber from which energy is extracted by a piston and crank mechanism driving a propeller. The turboprop engine has a propeller turned through a system of gears from a gas turbine system; it usually delivers more thrust--up to medium-high subsonic airspeeds. The majority of the commuter/taxi aircraft use this turboprop engine propulsion.

The pollutants emitted by an aircraft during take-off and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle includes landing and takeoff (LTO) cycle. An LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 2,300 feet on landing, and subsequent takeoff to reach the 2,300-foot altitude. The 2,300-foot limit is a reasonable approximation to the meteorological mixing depth over the Bay Area metropolitan areas. The term "operation" is used by the Federal Aviation Administration to describe either a landing or a take-off cycle. Therefore, two operations make one LTO cycle.

The aircraft LTO cycle is divided into five segments or operational "modes" categorized as:

1. Landing approach (descent from about 2,300 ft. to touch down),
2. Taxi/idle-in,
3. Taxi/idle-out,
4. Take-off,

5. Climb out (ascent from lift-off to about 2,300 ft.).

The emissions are based on the time of operation in each mode and the emission rates of the engines. The time for the landing approach and climb out modes are assumed to be 3.02 minutes and 1.55 minutes respectively. A take-off time of 0.95 minute is fairly standard for commercial aircraft and represents the time for initial climb from ground level to about 500 feet. For congested airports, the taxi/idle time can be as much as three to four times longer compared to uncongested airports. Typical duration for civil aircraft LTO cycles at large metropolitan areas are shown on AP-42, Table II-1-3.

There are many types of aircraft in use today. Only the commonly used commercial aircraft are considered in these categories.

Methodology

The number of operations and fleet mix were obtained from the three major commercial airports in the Bay Area and the Metropolitan Traffic Commission (MTC). Emission rates vary according to engine type and operating mode. Modal emission rates for aircraft engine now in general commercial use were obtained from AP-42, Table II-1-7 and the FAA Aircraft Engine Emission Database (version 2.5). Emission factors for a specific aircraft were estimated by the equation:

$$EMF = N \sum (v_e/v_t)_{m,p} \times TIM$$

Where EMF = Emission Factor, with units in lbs./LTO

N = number of engines,

$(v_e/v_t)_{m,p}$ = engine emission rates, lbs/hr at mode m, pollutant p, and

TIM = time in mode, hr.

Sample calculation (Cat. No. 1130):

Data: 10,961 LTO/yr.,
for ATR72 (Commuter/Taxi aircraft at SFO)
TOG emission factor = 5.07 lbs/LTO

Emission = 10,961 LTO/yr x 5.07 lbs./LTO / 365 days/yr / 2000 lbs/T
= 0.076 ton/day of organics

Monthly Variation

Monthly distribution was based on the monthly number of operations at each airport.

County Distribution

The county location of each airport was used to distribute emissions into each county, where SFO is in San Mateo County; OAK is in Alameda County, and SJC in Santa Clara County.

TRENDS

History

Emissions through the years were estimated based on the above methodology and the actual number of operations from each airport. Selected years were calculated with corresponding estimates of the aircraft fleet mix during those times.

Growth

The continuing effort in aircraft improvement, development of newer engine technology and their phasing in will result in reduced emissions. Airport noise regulations are forcing changes to the commercial aircraft fleet resulting in replacement of loud and inefficient engines with newer, quieter, and cleaner burning engines. There is a continuing trend in the use of larger aircraft thereby increasing the passenger to LTO ratio. This will reduce the number of LTOs and consequently, lower emissions.

It is difficult to project what will be the future mix of aircraft at each airport. The airline fleet modernization occurs continually and varies according to travel demand forecasts, changes in marketing strategy, cost of capital, and the financial situation of the individual airlines.

The projections for number of operations and fleet mix at each airport were developed from the airport data and the MTC's 1994 and 2000 Regional Airport System Plan (RASP). Emissions for selected years (1999, 2010 and 2020) were calculated based on the above methodology. Emission values for other years were obtained by interpolation.